Computer Basics

Computer Memories

Computer Memories

Identifying the Types of DRAM

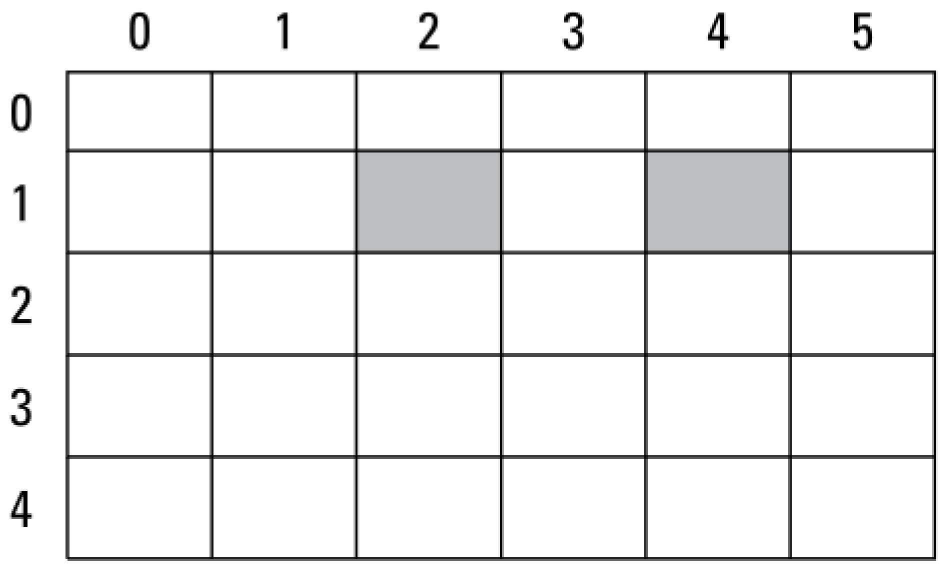
- DRAM is the most popular type of memory used in systems today.
- It is also the most popular type of memory that computer users add to their computers when upgrading memory.

Computer Memories

Identifying the Types of DRAM

- Memory is organized into rows and columns, like a spreadsheet.
- Information is stored in the different cells, or blocks, that are created by the intersection of these rows and columns.
- With DRAM, the CPU requests data from the memory controller by sending the address of the row and the address of the column for every block of data that needs to be read.
- The memory controller then fetches the information from that memory location.

Looking at how data is accessed in memory



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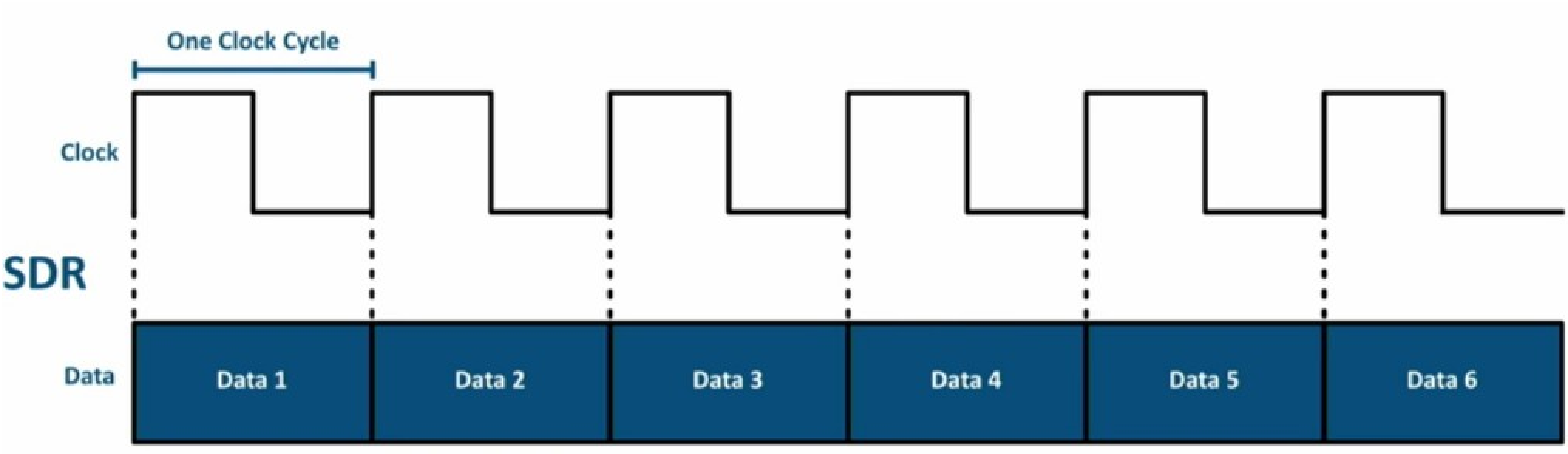
Identifying the Types of DRAM

- **Synchronous DRAM**
- synchronous DRAM (SDRAM) is memory synchronized to the system board speed.
- This synchronized speed means that the data stored in memory is refreshed at the system speed, and data is accessed in memory at the system speed as well.
- SDRAM is one of the most popular types of DRAM found in earlier Pentium systems, such as the Pentium II.
- When you upgrade memory on your system and you determine that you need SDRAM, you then need to determine what speed of SDRAM.
- Because you are running at the system speed, you must match the DRAM speed with the motherboard speed.
- Thus, if you have a 100 MHz motherboard, you need 100 MHz SDRAM. If you have a 133 MHz motherboard, you need 133 MHz SDRAM.

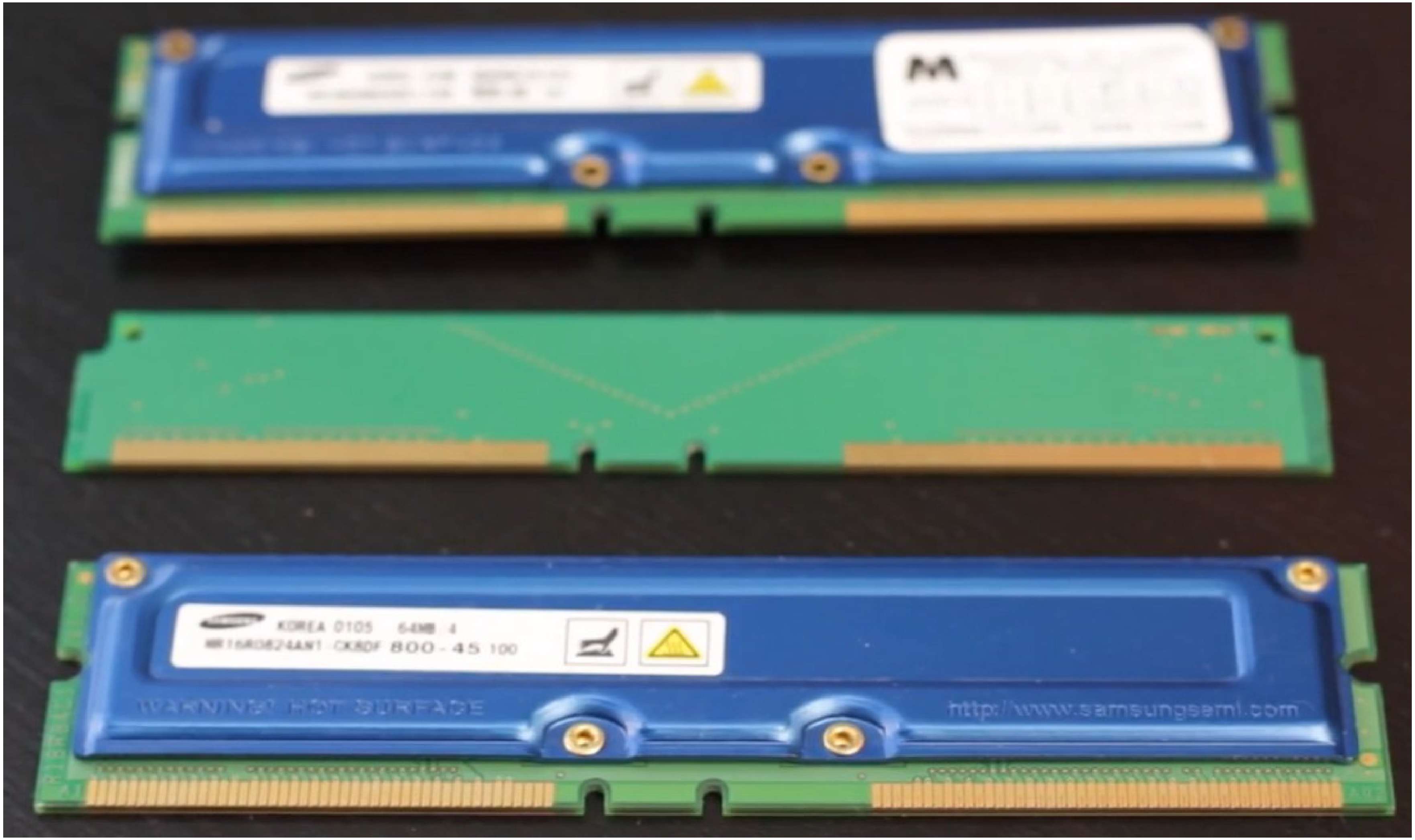
Synchronous DRAM



Computer Memories

Identifying the Types of DRAM

- **Rambus DRAM**
- When SDRAM was popular, a high-speed flavor of DRAM was on the market — rambus DRAM (RDRAM) — which runs at speeds around 800 MHz!
- RDRAM chips have a 16-bit internal bus width and are packaged together in a 184-pin, gold-plated memory module called a rambus inline memory module (RIMM).
- To take advantage of this type of memory, you need a motherboard and chipset that support RDRAM.
- Due to the cost of RDRAM, it lost the popularity contest to SDRAM and eventually DDR memory.


KOREA 0105 64MB 4
800-45
WARNING! HOT SURFACE
http://www.samsungsemi.com

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Identifying the Types of DRAM

- **DDR**
- Double data rate (DDR) memory gets its name from the fact that it can transfer data twice during each clock cycle, compared with SDRAM that can transfer data only once per clock cycle. DDR memory ships in 184-pin DIMM modules for desktop computers and 200-pin SODIMMs for laptop systems.

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Identifying the Types of DRAM

- **DDR**
- DDR memory speed is measured in MHz, like SDRAM is, and is labeled to indicate the speed. DDR memory labeling might look obscure at first because it also indicates the bandwidth by taking the speed and multiplying it by 8 bytes of data (64 bits).
- Here's how to read DDR memory labeled as PC-1600: Divide the 1600 by 8 bytes to get the speed of the memory.
- In this case, you are looking at 200 MHz memory. PC-2700 runs at 333 MHz, and PC-3200 runs at 400 MHz.
- When you upgrade memory on systems that require DDR memory, you need to know the speed of the DDR memory.

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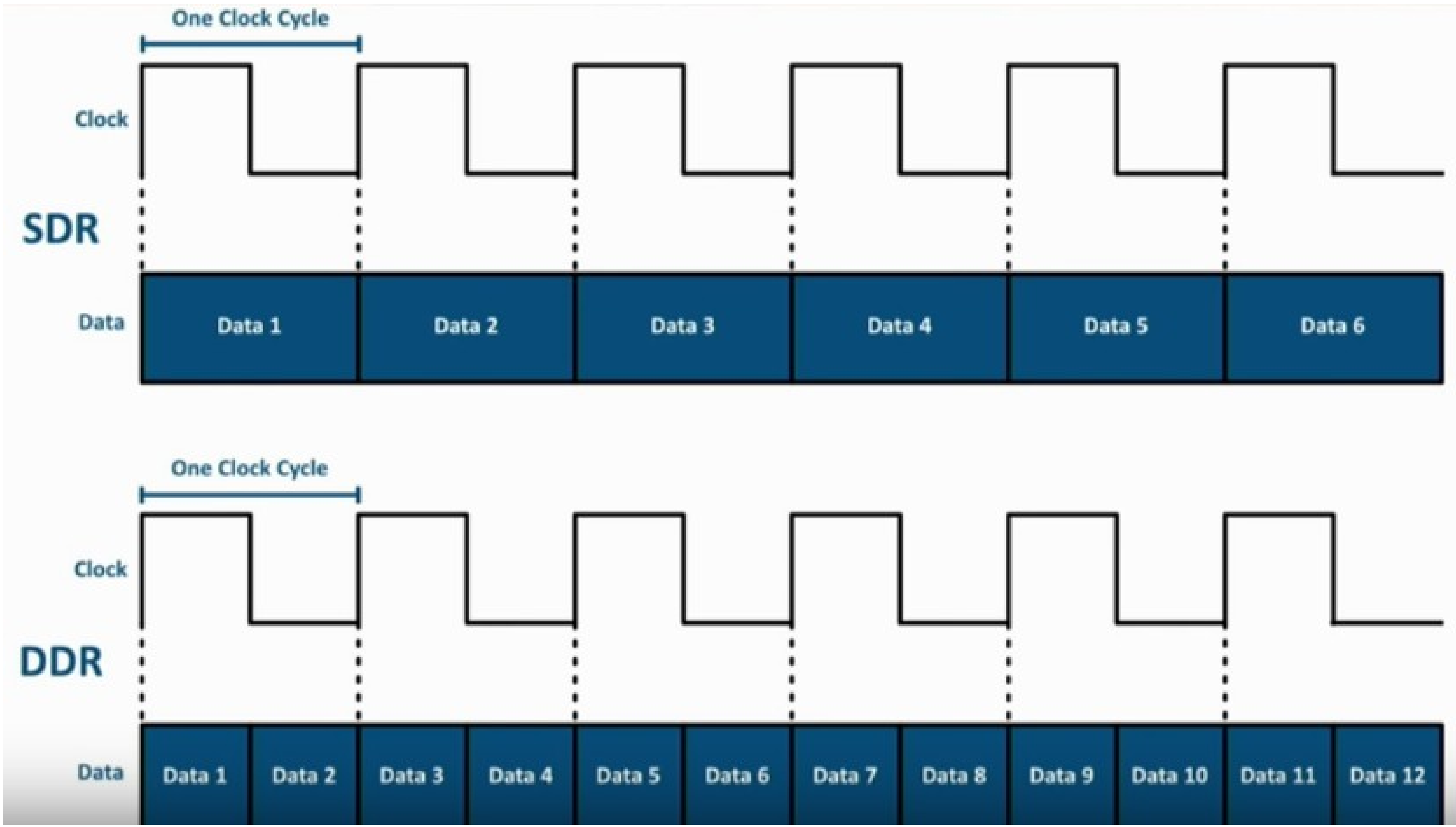
Identifying the Types of DRAM

- **DDR**
- Different RAM speeds for DDR memory are:
  - PC-1600 (200 MHz)
  - PC-2100 (266 MHz)
  - PC-2400 (300 MHz)
  - PC-2700 (333 MHz)
  - PC-3200 (400 MHz)


One Clock Cycle
Clock
SDR
Data
Data 1
Data 2
Data 3
Data 4
Data 5
Data 6
One Clock Cycle
Clock
DDR
Data
Data 1
Data 2
Data 3
Data 4
Data 5
Data 6
Data 7
Data 8
Data 9
Data 10
Data 11
Data 12

Identifying the Types of DRAM

- **DDR 2**
- Improvements to DDR memory have already started with DDR2 memory, which runs at speeds 400 MHz and higher, where DDR memory left off.
- DDR2 memory uses 240-pin memory modules and runs at 1.8 volts (V), as opposed to 2.5V for DDR memory.
- This results in less power consumption for more memory, which is great for laptop users.
- Popular modules of DDR2 memory are:
  - PC2-3200 (400 MHz)
  - PC2-4200 (533 MHz)
  - PC2-5300 (666 MHz)
  - PC2-6400 (800 MHz)

Computer Memories

Identifying the Types of DRAM

- **DDR 3**
- The newer form of DDR memory is DDR3, which offers twice the data rate of DDR2 memory.
- One of the goals of DDR3 memory is to reduce power consumption; reportedly, DDR3 memory reduces power consumption by about 30 percent.
- Common speeds of DDR3 are:
  - PC3-6400 (800 MHz)
  - PC3-8500 (1066 MHz)
  - PC3-10600(1333 MHz)
  - PC3-12800 (1600 MHz)

Computer Memories

Identifying the Types of DRAM

- **DDR 3**
- DDR memory modules are 240-pin DIMMs for desktop PCs and 204-pin SODIMMs for laptop systems.
- Like DDR2, DDR3 memory is advertised by the speed and transfer rate.
- For example, DDR3-800 (also known as PC3-6400) is 800 MHz memory that has a throughput of 6400 MBps.
- DDR3-1066 (also known as PC3-8500) memory has a throughput of 8533 MBps.
- Another example is DDR3-1600, which is 1600 MHz memory with a transfer rate of 12,800 MBps.


40H8714
FRU:42H2797
MB 60NS 4M X 64
IBM
WARRANTY VOID IF REMOVED
OPT:
HIT
PC3200 512MB DDR400
P/N: D32PB12C
WARRANTY VOID IF TAMPERED
Super★Talent
www.supertalentmemory.com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Computer Memories

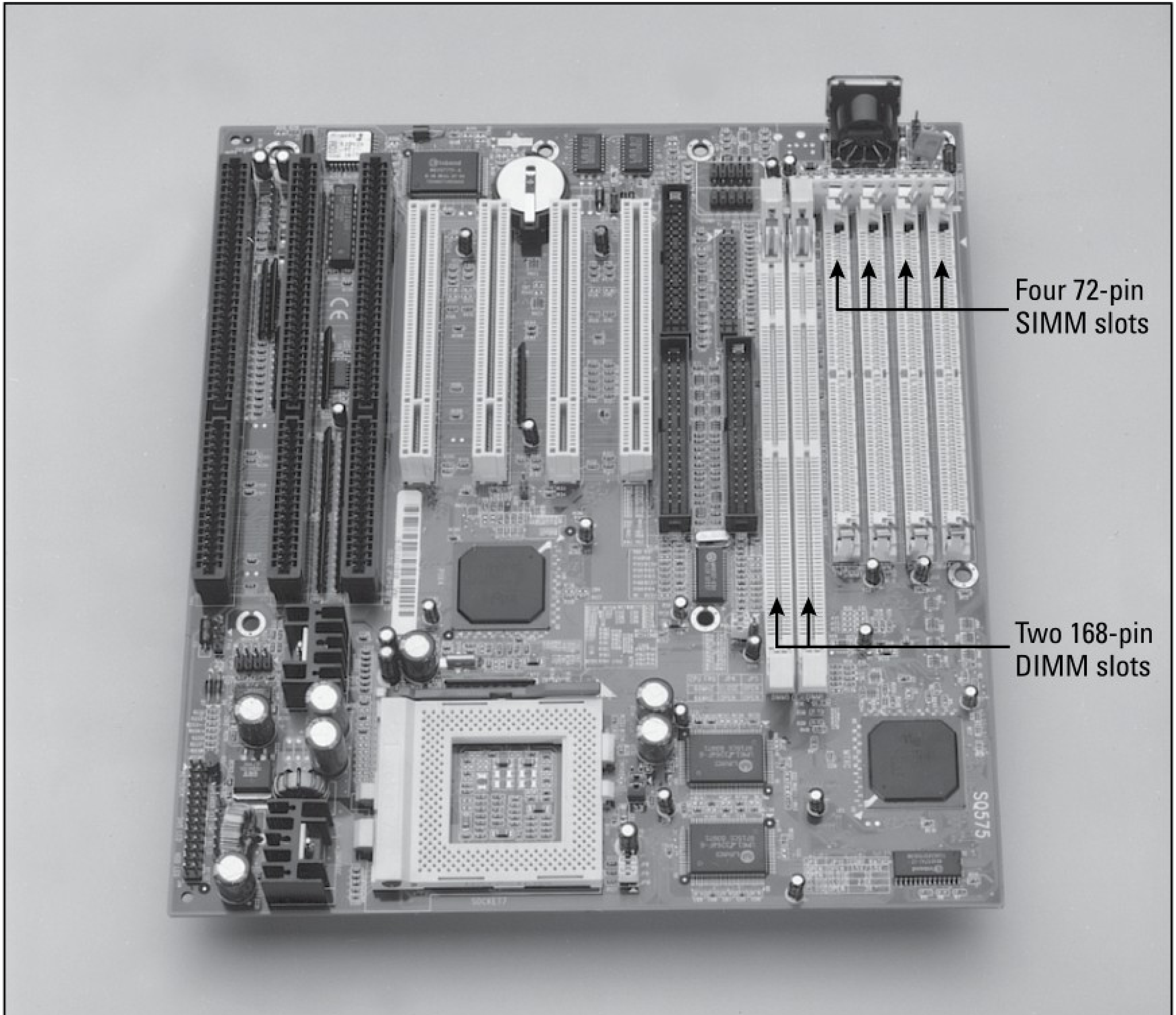
How Would You Like Your Chips Packaged?

- **DIMMs**
- Dual inline memory modules (DIMMs) are how we package and install memory today.
- A DIMM card holds a number of memory chips and has an edge connector containing a number of pins that make contact with the motherboard.
- This design makes it quite a bit easier to install memory than it was many years ago.
- In the past, you had to take a dual inline package (DIP) chip out of the system board and reinsert a new chip. Today, you purchase a card of chips (a DIMM) and install the DIMM into one of the DIMM sockets.

Computer Memories

How Would You Like Your Chips Packaged?

- **DIMMs**
- DIMMs supply information in 64-bit chunks.
- When installing memory into a system, you must install enough DIMMs to fill a memory bank, which is the number of DIMMs it takes to fill the data path of the processor.
- Because DIMMs are 64-bit modules, and the processors today are 64-bit, you only need to install one DIMM to fill a bank.
- DIMMs come in different flavors that have a different number of pins on the modules. Older DIMMs use 168 pins for SDRAM and 184 pins for DDR memory, and newer DIMMs use 240 pin modules for DDR2 and DDR3 memory.


Four 72-pin SIMM slots
Two 168-pin DIMM slots

Computer Memories

How Would You Like Your Chips Packaged?

- **DIMMs**
- The original DIMMs were 168 pins. DDR DIMMs come with 184 pins, and DDR2 and DDR3 DIMMs use 240-pin modules. DIMMs are also the most popular type of memory module that you will find in systems today

Computer Memories

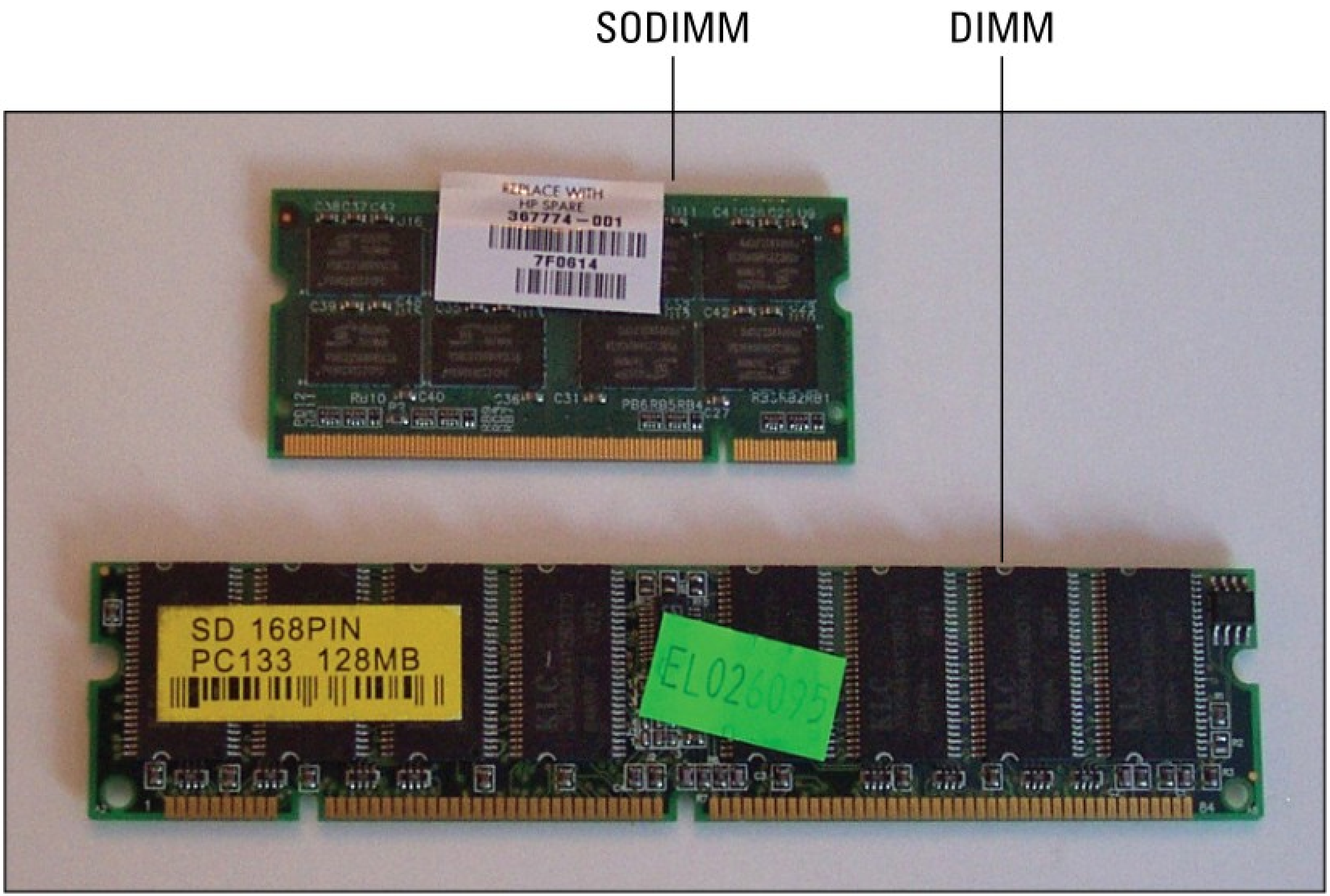
How Would You Like Your Chips Packaged?

- **SODIMM**
- Small outline dual inline memory modules (SODIMMs) are memory modules that are smaller than normal DIMMs and are used in laptops.
- A SODIMM comes in three different-sized modules:
  - a 32-bit 72-pin module;
  - a 64-bit 144-pin module (SDRAM);
  - and a 64-bit 200-pin module for DDR and DDR2 laptop memory.

Computer Memories

How Would You Like Your Chips Packaged?

- **MicroDIMM**
- A micro dual inline memory module (MicroDIMM) is another memory module used in laptop computers.
- The MicroDIMM is smaller than the SODIMM and comes in a 144-pin module for SDRAM and a 172-pin module for DDR memory.


SODIMM
DIMM
367774 – 001
7F0614
SD 168PIN
PC133 128MB

Computer Memories

Understanding Error-Checking Memory

- Two primary types of error-checking memory have been used in systems over the years. The following sections introduce you to these two types of error-checking memory

Computer Memories

Understanding Error-Checking Memory

- **Parity versus nonparity**
- Parity memory is a type of error-checking memory, which is memory that verifies the information stored in memory is what is actually read from memory at a later time.
- Nonparity memory, comparatively, is memory that does not perform any kind of error checking to ensure that the data written to memory is what is actually read when it is retrieved.

Computer Memories

Understanding Error-Checking Memory

- **Parity versus nonparity**
- With parity memory, for every byte (8 bits) of data written to memory, there is an additional ninth bit — the parity bit.

– Even parity byte

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Parity Bit
0	0	0	0	0	1	1	1	1
0	0	0	0	0	0	1	0	0
0	1	1	0	0	1	0	0	1

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Understanding Error-Checking Memory

- **Parity versus nonparity**
- When the CPU requests data from memory, the data byte is retrieved along with the parity bit that was generated when the byte of information was stored in memory.
- The system looks at the data byte and calculates whether the parity bit stored in memory should be set to 1 or 0.
- It then compares the answer it has just generated with the value of the parity bit stored in memory.
- If the two match, the integrity of the information in memory is considered okay, the parity bit is stripped from the data byte, and the data is delivered to the CPU. If the two differ, you have a parity error, meaning that there is a problem with the integrity of the data stored in memory.
- Parity memory cannot correct the error; it just reports that an error exists

Computer Memories

Understanding Error-Checking Memory

- **ECC versus non-ECC memory**
- Error-checking and correction (ECC) memory is memory that can detect data integrity problems the way that parity memory can.
- The difference between the two is that ECC memory can recover from the error and attempt to fix the problem with the data being read, whereas parity memory cannot.
- Memory that does not have ECC features is known as non-ECC memory as there are no error-checking and correction capabilities.

Computer Memories

Multichannel Memory Architecture

- The memory architecture in a system may depend on its age:
  - Older systems only used a single-channel memory configuration.
    - A single-channel configuration mandates a “single lane” used to send and receive information from memory.
  - When installing memory today, your system may support methods to increase memory throughput by using multiple channels.

Computer Memories

Multichannel Memory Architecture

- **Dual channel**
  - With some of today's systems, though, you can install memory in a dual-channel configuration, which allows for two 64-bit lanes to carry information to and from memory at the same time — resulting in better performance, as the amount of data sent at one time is doubled compared to that on a single-channel architecture.
  - This configuration increases overall performance by allowing for more input/output per operation, or clock cycle.

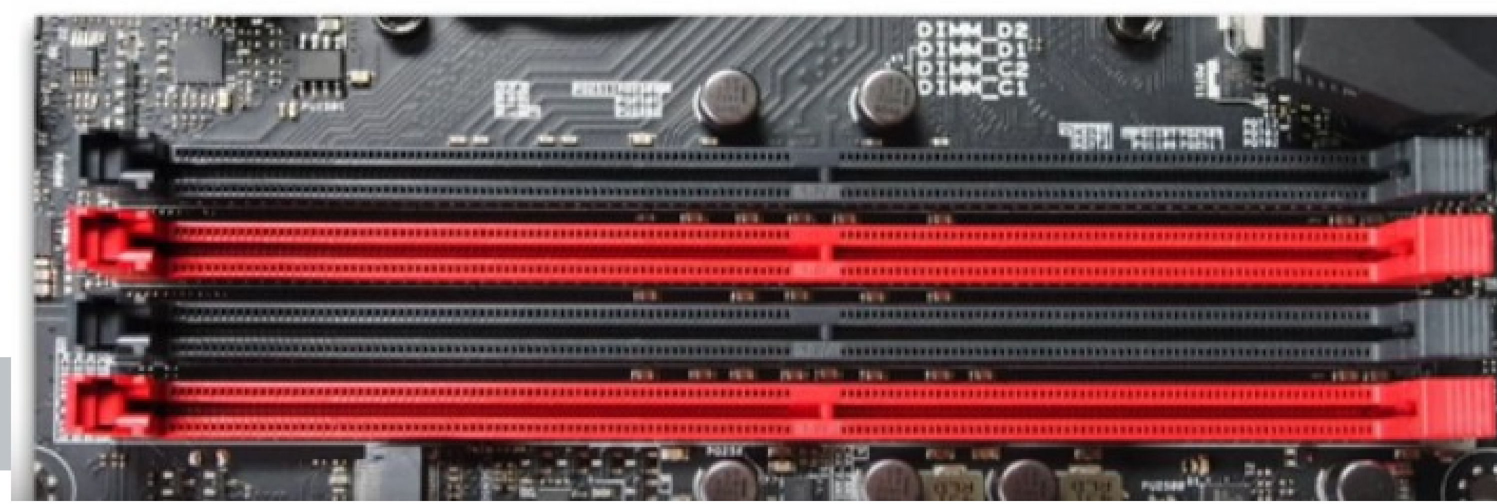
Computer Memories

Multichannel Memory Architecture

- **Dual channel**
  - To take advantage of dual-channel memory, you first need to ensure that your motherboard supports dual channel, as dual-channel memory is a function of the memory controller.
  - You also need to be using DDR, DDR2, or DDR3 memory to take advantage of dual-channel architecture.
  - If your motherboard supports dual-channel memory, you will install the memory modules in pairs. These pairs must be similar modules in capacity and speed.

Multichannel Memory Architecture

- **Dual channel**
  - For example, when installing 4GB of RAM, you install two 2GB modules. When you install these modules, install them into the same color slots on the motherboard, usually colored either black or blue.
  - If the motherboard does not color-code the memory slots, you install the pair of memory modules in the odd-numbered slots or the even-numbered slots — but not an odd and an even.



Multichannel Memory Architecture

- Triple and quadruple channel
  - Some systems today are supporting these architectures:
  - Triple-channel memory architecture allows three 64-bit lanes.
    - For example, Intel's i7-900 series processors support triple-channel memory architectures.
  - Quadruple-channel memory architecture allows four 64-bit lanes.
    - The AMD G34 platform and the Intel LGA 2011 platform are examples of quadruple-channel memory architectures.

Computer Memories

Multichannel Memory Architecture

- **Triple and quadruple channel**
  - The same rules as dual channel memory apply when using triple and quadruple channel memory architectures: You must use similar memory modules, but you will be required to install either three modules (for triple-channel) or four modules (for quadruple-channel) at a time.

Multichannel Memory Architecture

- **Triple and quadruple channel**
  - With both triple and quadruple channel architectures, if you only install a pair of modules, the system will run the memory in a dual-channel architecture.
  - You can purchase dual-channel or triple-channel memory kits to ensure that you are using the same type of memory and the same speed.
  - You do not need to use these kits, but you are paying for the fact that someone has already tested the memory in a dual-channel configuration.
  - Some benchmarks report that you can achieve a 65 percent increase in memory performance by using a multichannel configuration.

Computer Memories

Single-Sided versus Double-Sided Memory

- Memory modules are either single-sided or double-sided memory modules, but this characteristic does not mean that the memory chips exist on only one side of the memory card or both sides of the memory card (which is what most people think).

Computer Memories

Single-Sided versus Double-Sided Memory

- For single-sided memory, all the memory on the memory module is accessed at once by the system and is treated as a single “bank” of memory.
- It is important to note that the memory chips on a single-sided memory module may exist on both sides of the memory board.
- For double-sided memory, the memory module (or memory board) is divided into two discrete chunks of memory (banks).
- The system can access only one bank at a time. Original double-sided memory modules were created by taking two single-sided memory modules and connecting them.
- Original double-sided memory modules were created by taking two single-sided memory modules and connecting them.

Computer Memories

Buffered versus Unbuffered Memory

- When purchasing servers (a high-end system that provides services to the entire company) for an organization, you may come across the term buffered and unbuffered memory.
- Buffered memory, also known as registered, is memory that contains registers that are used to store data before sending it to the CPU.

Computer Memories

Buffered versus Unbuffered Memory

- This stored data is retained for an extra clock cycle to act as a reliability feature. Buffered memory is typically found in network servers because they have many memory modules putting stress on the system where the extra reliability is needed.
- Unbuffered memory is memory that does not have registers to store information and, as a result, the memory is not as reliable. The benefit of unbuffered memory is that it has less overhead (because it is not taking time to store information in registers) and therefore, it is faster memory than buffered memory.

Computer Memories

Working with Cache Memory

- Cache memory stores frequently used data and program code after it is read from slower DRAM.
- Cache memory is made up of SRAM, which is much faster than DRAM.
- The average speed of DRAM in the past was 60 ns, whereas the average speed of SRAM at the same time was 20 ns.
- If at all possible, you want the CPU's request for information to be serviced by cache memory for a quicker response.
- To help service these responses, the system has different levels of cache memory: L1, L2, and now L3 cache, which is common on systems today.

Computer Memories

Working with Cache Memory

- **L1 cache**
  - Originally, Level 1 (L1) cache meant “internal cache” integrated into the CPU.
  - This memory is typically a small amount of SRAM integrated into the processor’s chip, giving the processor instant access to this memory with no wait time.
  - Wait time is how long it takes between when the processor requests information stored in memory and it actually receives that information.
  - Every pre-Pentium processor had L1 cache integrated into the processor chip, but the amount of L1 cache can vary.

Working with Cache Memory

- **L1 cache**
  - For example, the old 486 chips had 8K of L1 cache, whereas the original Pentium processors had 16K of L1 cache. Processors today have doubled that amount to 32K of L1 cache.
  - The L1 cache is typically divided into two parts:
    - Half the cache is used to store frequently accessed program instructions.
    - The other half of the cache stores frequently accessed program data.

Computer Memories

Working with Cache Memory

- **L2 cache**
  - Level 2 (L2) cache exists outside the CPU, usually on the motherboard or just outside the processor but in the processor casing. Therefore, some delay occurs when the processor accesses the information in L2 cache because of the distance between the processor and the L2 cache.
  - Originally, L1 cache was SRAM integrated into the processor's chip, whereas L2 cache was SRAM located outside the CPU, on the system board. Today's systems have L1 and L2 integrated into the CPU.

Computer Memories

Working with Cache Memory

- **L2 cache**
  - One of the selling points of different processors is the amount of cache memory that comes with the processor. Many processors today typically have at least 32K of L1 cache and 512K, 1MB, 2MB, or more of L2 cache inside the casing of the processor. My Intel i7 system has 128 KB of L1 cache and 2 MB of L2 cache. The more cache memory a system has, the bigger the bucket to store more frequently used information.

Computer Memories

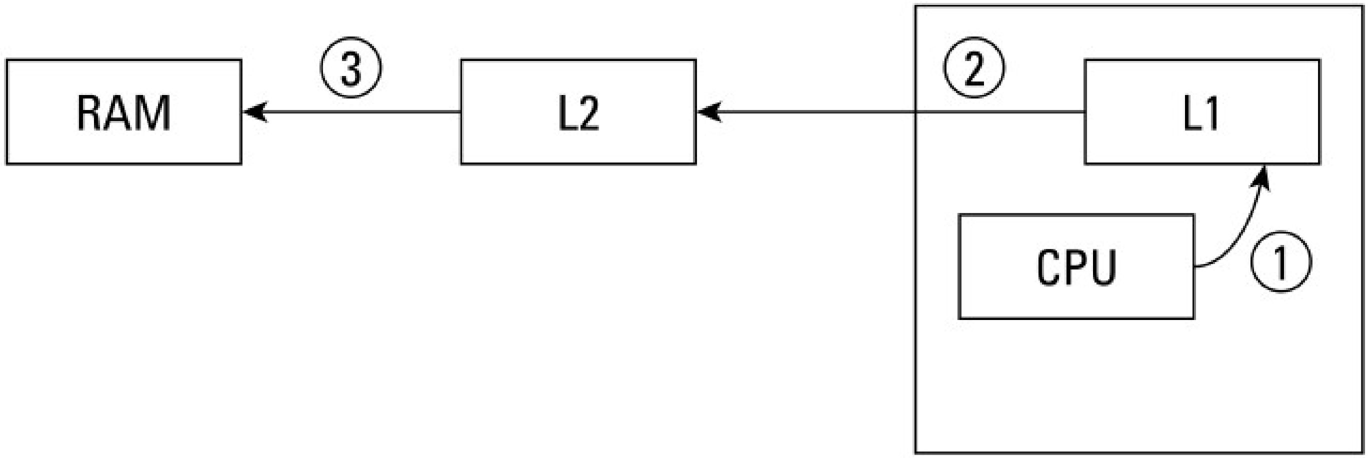
Working with Cache Memory

- **L2 cache**

1) When the processor retrieves information, it checks whether the information is stored in L1 cache (because L1 cache has no wait time).

2) If the processor does not find the information in L1 cache, it checks the next level — L2 cache.

3) If the information cannot be found in either L1 or L2 cache, the processor finally retrieves the information from system RAM.



Working with Cache Memory

- **L3 cache**
  - Because processors today provide a small amount of L1 cache and a large amount of L2 cache, the term L3 cache was used originally to identify cache that resides on the motherboard.
  - Today's processors are now marketing a third level of cache, known as L3, which is cache memory that resides on the processor that is shared between each processor core. This means that each core typically has its own L1 and L2 cache, while they share a larger amount (usually 6 to 8 MB) of L3 cache!

Thanks For Attention